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ELECTRIC DISCHARGE DEVICE

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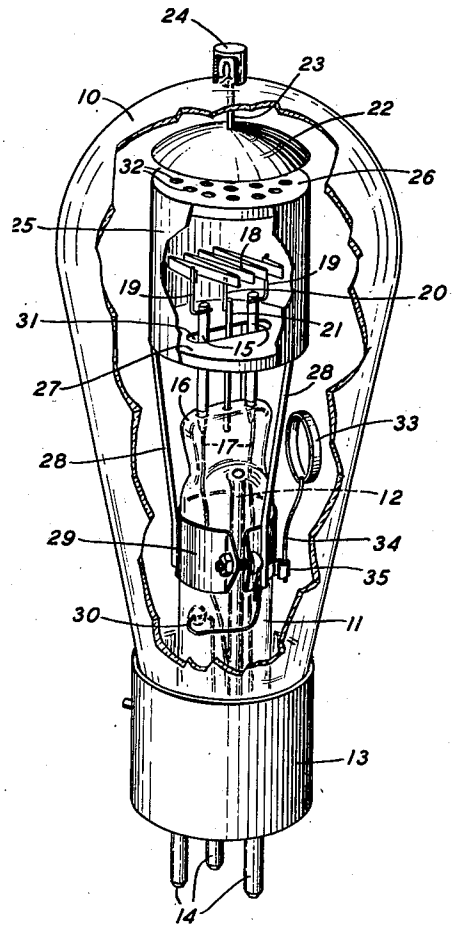


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## ELECTRIC DISCHARGE DEVICE

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3 Claims. (Cl. 250—27.5)

This invention relates to electric discharge devices and more particularly to gaseous discharge devices employing an electron emitting cathode.

In three-electrode discharge devices having an electron emitting cathode and a filling of an inert gas at low pressure, the initiation of the electron discharge between the cathode and the anode may be controlled by the grid potential. For instance, for each anode potential there is a corresponding value of grid bias or potential above which the device will not break down, that is, no discharge between the cathode and the anode may occur. After the initiation of the discharge the grid normally loses control so that the device may be utilized as a trigger valve, for example, to operate a relay when the input and consequently the grid potential reaches a predetermined value.

The ratio of anode potential to grid potential at the critical or breakdown point approaches a constant for large values of these potentials and is commonly termed the control ratio or amplification factor of the device. The amplification factor depends almost entirely upon the largest effective opening in the grid structure and it is, of course, desirable that this factor be accurately known and determinable.

An object of this invention therefore is to enable the accurate determination of the amplification factor in three-electrode gaseous discharge devices.

Another object of this invention is to increase the efficiency and the power capacity of three-electrode gaseous discharge devices.

In accordance with this invention the discharge device comprises a cathode capable of emitting electrons when heated, an anode adjacent the cathode and a control electrode or grid having a portion interposed between the cathode and anode. The cathode and grid are supported from a stem of the enclosing vessel and the anode is supported by a leading-in wire sealed in the vessel. The enclosing vessel is filled with an inert gas such as argon at low pressure, or a filling of mercury injected into the vessel. Mercury is preferably employed since it has a low vapor pressure and further increases the power capacity of the device. The cathode comprises a folded ribbon having an alkaline earth oxide coating the turns of which are closely spaced with respect to one another to increase the heat conductivity therebetween and thereby to decrease the input power required to heat the cathode to the desired temperature. The edges of the folds of the cathode are preferably substantially parallel to the base of the anode so that a large electron emitting surface is presented to the anode and a uniform discharge of relatively high intensity is made possible. A control electrode or grid completely encases the cathode on all sides and comprises a hollow metallic member having a portion between the anode and cathode perforated.

Since the amplification factor is dependent upon the largest effective opening in the grid or control electrode, the total effective area of the apertures in the perforated portion is made greater than the effective area of the central aperture in the other end portion. The construction of the electrodes and their relation to one another enables the accurate determination of the amplification factor of the device and furthermore increases the efficiency and capacity of the device.

The various features and details of the electric discharge device of this invention will be understood more readily with reference to the accompanying drawing, in which the single figure is a perspective view of an electric discharge device made in accordance with this invention with portions broken away to show the internal electrode assembly.

Referring to the drawing, the electric discharge device of this invention comprises an enclosing vessel 10 having a hollow reentrant stem 11 in which a central evacuating tubulature 12 is sealed. The vessel 10 is cemented or otherwise suitably attached to an insulatory base 13 carrying terminal pins 14. A pair of metallic rigid rods 15, preferably of nickel, embedded in the press portion 16 of the stem 11 and welded to leading-in wires 17 terminating in two of the terminal pins 14, support a filamentary cathode 18, adapted to emit electrons. The rods 15 are attached to the ends of the cathode 18 through intermediate relatively thin links 19, likewise preferably of nickel, welded to the ends of the cathode 18 and the rods 15. The links 19 become heated during the operation of the device and serve to increase the thermal efficiency of the cathode. The cathode 18 in a preferred embodiment may take the form of a relatively wide nickel ribbon coated with alkaline earth oxides, such as barium and strontium oxides, folded to form a zig-zag or accordion pleated electrode, the turns of which are closely adjacent one another to increase the heat conductivity therebetween and thereby to maintain the temperature of the cathode constant and uniform. The cathode 18 is supported at its center through an intermediate link 20 by a rigid metallic rod 21 embedded in the press 16

and serving to prevent sagging of the center portion of the cathode and to maintain the anode at substantially right angles to the stem 11. This construction provides a cathode having a large electron emitting surface to supply a large electron flow to the anode.

A dome shaped anode 22, preferably of carbonized nickel, is supported with its base parallel to the edges of the folds of cathode 18 by a rigid leading-in wire 23 sealed in the tip of the vessel 10 and connected to a metallic cap 24 cemented to the vessel 10 which serves as the external terminal for the anode 22.

A control electrode or grid surrounds the cathode 18 and comprises a cylindrical portion 25 and two flanged disc end portions 26 and 27 parallel to the cathode 18, formed preferably of nickel. The control electrode is supported by a plurality of rods 28 welded to the end portion 27 and to a split metallic collar 29 clamped about the stem 11. A leading-in wire 30 for the grid is sealed in the side of the stem 11, welded to the collar 29, and connected externally to one of the terminal pins 14. The end portion 27 of the grid is provided with an elongated aperture 31 to allow passage of the rods 15 and 21, and the end portion 26 is provided with a plurality of equally spaced apertures 32 through which the discharge between the cathode 18 and the anode 22 occurs. Since the control ratio or amplification factor of the device is largely dependent upon the aperture of largest effective area in the grid with respect to the cathode, the total effective area of the apertures 32 of the portion 26 is made greater than the effective area of the aperture 31 and is proportioned primarily to accurately determine the amplification factor. The end portion 26 also provides a barrier between the cathode 18 and the anode 22 and serves to focus the discharge between these electrodes. Furthermore, since the grid completely surrounds the cathode 18 on all sides, it forms a heat reflecting shield and thereby increases the thermal efficiency of the cathode.

An annular grooved ring 33 carries a vaporizable material such as magnesium, to absorb residual gases after the final evacuation of the device is completed and is mounted on a wire 34 welded to a metallic band 35 affixed to the collar 29. After the electrodes are assembled in the device the vessel is evacuated and a definite volume of mercury is injected into the vessel 10 through the inlet tube 12 in accordance with a method disclosed and claimed in my Patent No. 1,918,244, granted July 18, 1933. Although any inert gas, such as argon, may be utilized as the conducting medium in the device, mercury vapor is preferred since it enables the use of lower pressures in the device and permits the operation of the device at high anode potentials. For example, with a filling of mercury vapor at a pressure of the order of .001 millimeter of mercury, an electric discharge device of relatively small dimensions and constructed in accordance with my invention may be used with anode potentials in excess of 6000 volts and a discharge current of the order of one ampere or greater.

It is to be understood that the specific structure of the electrodes in accordance with this invention and the shape of the openings in the end portion 26 of the control electrode may be widely varied in accordance with the characteristics which are desired, and such variations do not depart from the spirit and scope of this invention as defined in the appended claims.

What is claimed is:

1. A mercury vapor discharge device comprising an enclosing vessel having a stem, a cathode supported from said stem and composed of a zigzag ribbon having closely adjacent folds disposed with corresponding longitudinal edges thereof in a plane, a dome shaped anode having its base substantially parallel to said corresponding edges of the folds of said cathode, a collar encircling said stem, and a control electrode supported from said collar comprising a hollow imperforate portion spaced about said cathode, and two end portions substantially parallel to said edges of the folds of said cathode, one of said portions being perforated and disposed between said anode and cathode.

2. An electric discharge device comprising an enclosing vessel having an ionizable medium therein and also having a stem, an incandescible cathode, leading-in wires for said cathode embedded in said stem, an anode adjacent said cathode, a collar on said stem, and a control electrode supported from said collar and surrounding said cathode comprising a body portion and two end portions, one of said end portions being disposed between said cathode and said anode and being apertured for the passage therethrough of the discharge between said cathode and said anode, and the other of said end portions having an elongated aperture therein through which said leading-in wires pass, the area of the aperture being greater than the area defined by a line encircling said leading-in wires, whereby space insulates said leading-in wires from said control electrode.

3. An electric discharge device comprising an enclosing vessel having an ionizable medium therein and having also a stem, a control electrode comprising a cylindrical body portion, a flat apertured top portion and a bottom portion having an elongated aperture therein, a dome-shaped anode adjacent said top portion and having its concave surface directed toward and its base substantially parallel to said top portion, an incandescible cathode within said control electrode composed of a folded relatively broad metallic ribbon coated with a thermionic material, the folds of said ribbon being closely adjacent and having corresponding edges disposed in a plane adjacent and parallel to said apertured top portion, leading-in conductors sealed in said stem, extending through the aperture in said bottom portion and secured to the ends of said ribbon, and additional supporting means sealed in said stem, extending through said aperture and engaging said ribbon intermediate the ends thereof.

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